MALACOLOGIA, 1982, 22(1–2): 553–558

PROC. SEVENTH INTERNATIONAL MALACOLOGICAL CONGRESS

# DISTRIBUTION, ZONATION AND HABITS OF A TROPICAL MUD SNAIL *CERITHIDEA CINGULATA* (GMELIN) (MOLLUSCA: GASTROPODA)

M. Balaparameswara Rao and R. V. Sukumar

*Department of Zoology, Nagarjuna University, Nagarjunanagar 522510, South India*

## ABSTRACT

Some observations were made on the distribution, zonation and habits of a tropical mud snail *Cerithidea cingulata* (Gmelin) at Nizampatnam (15°54′ N; 80°43′ E) in the Krishna estuarine region on the east coast of south India. The distribution of the snails was studied at four different tidal levels at 20 stations located on the mud flats on either side of the Nizampatnam canal. The snails prefer mid tide level and they were most abundant in the shallow regions. Laboratory studies have shown that *C. cingulata* is negatively geotactic when immersed and positively geotactic when exposed. The results of the present study are discussed and also compared with those in other mud snails, particularly in the temperate forms.

## INTRODUCTION

While extensive investigations have been carried out on the distribution and behaviour of temperate mud snails, especially *Hydrobia* spp. (Newell, 1962, 1964, 1965; Anderson, 1971; Fenchel, 1972; Fenchel, Kofoed & Lapphainen, 1975; Little & Nix, 1976) and *Nassarius* sp. (Crisp, 1969; Pechenik, 1978), very little is known about the tropical forms. The genus *Cerithidea* is common in the tropical estuaries and has a wide distribution in the Indo-Pacific mangroves (Macnae, 1968). The distribution of *Cerithidea* spp. in the Malayan mangroves has been studied by many workers (Lim, 1963; Macnae, 1968; Berry, 1975).

*Cerithidea cingulata* is common in the mangrove swamps on the east coast of India (Radhakrishna & Janakiram, 1975; Murty & Balaparameswara Rao, 1977), and a perusal of the literature indicates that no comprehensive investigation has been carried out on the ecology of this species. The present report on *C. cingulata* is a part of a detailed study and is based on observations made at Nizampatnam, South India, from January 1979 to July 1980.

## PHYSIOGRAPHY OF THE AREA

Nizampatnam (15°54′ N; 80°43′ E) is a major fishing centre in the Krishna estuarine region on the east coast of south India. There are no perennial rivers emptying into the sea in the near vicinity of Nizampatnam, but about 35 km south east, river Krishna, the second largest perennial river in south India, opens into the Bay of Bengal (Fig. 1). In addition, a number of canals (the major being Nizampatnam and Gokarnamatam canals and Palrevu, Rellakalva and Gudderu) open into the Bay of Bengal, at Nizampatnam, resulting in the formation of an extensive area of swampy ground with scattered to dense mangroves (Fig. 2).

## SITE AND METHODS

Observations were made at 20 stations located on either side of Nizampatnam canal, over a 3 km length from the mouth of the canal to the Nizampatnam bridge (Fig. 2). The width and depth of this canal at Nizampatnam range from 35 to 50 m and 1 to 6 m, respectively. The canal receives water from the river Krishna and empties into the Bay through the Gokarnamatam canal. During high tide,

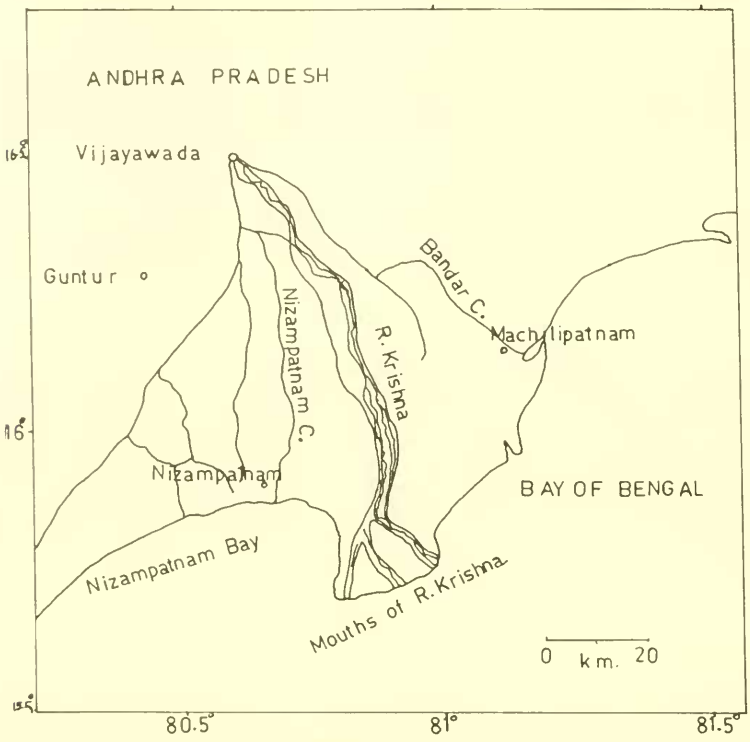


FIG. 1. Location of Nizampatnam and mouths of River Krishna.

sea water enters the canal and marine influence is seen as far as the Nizampatnam bridge. Stations 1 to 10 are located on the eastern bank and stations 11 to 20 on the western bank, are about 300 m apart, each extending towards the mouth of the canal.

At each station, observations were made at four tidal levels, namely low tide, high tide and 5 and 10 m from the high tide mark. These studies were carried out during successive high and low tide periods. At high tide the water level on the bank was noted, usually by identifying a plant or inserting a stick into the mud. The low water mark was also similarly identified during the following low tide period. The distance between the two marks was measured and at each level a $m^2$ area was identified and all mangrove plants and *Cerithidea cingulata*, were counted.

## RESULTS

### Distribution and zonation

The distribution of *Cerithidea cingulata* was studied from January to December 1979, on the mud flats present on either side of the Nizampatnam canal. Conspicuous differences in the distribution and density of the snails were found between the first and second halves of the year. The snails were more abundant and widely distributed during February–May period, whereas during June–January they were sparse and confined to small pools and creeks receiving drainage from the mangroves.

Table 1 (A,B) shows the density of *C. cingulata* at four different levels at stations 1 to 10 on the eastern bank (Table 1A) and stations 11 to 20 on the western bank (Table 1B) of the Nizampatnam canal, during February–May period. The profiles of 50 m transects with the distribution of *C. cingulata*, grasses, sedges and mangrove vegetation on the western bank at stations 12, between 15 and 16, and 20, is shown in Fig. 3.

*C. cingulata* were found to extend from MLWN to MHWS, but they were more common at the mid

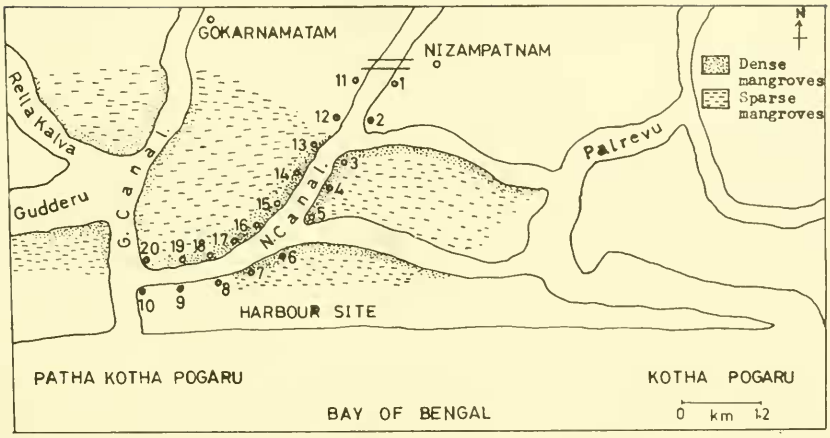


FIG. 2. Map of Nizampatnam showing the distribution of mangroves and location of stations 1 to 20. (N. Canal = Nizampatnam canal; G. Canal = Gokarnamatam canal).

TABLE 1. Population density (Average No. m$^2$) of *C. cingulata* at four different levels during February–May period.

A: on the eastern bank at stations 1–10.

| | Stations | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Level | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| MTL | — | — | — | 18 | 20 | 46 | 85 | 63 | 47 | 63 |
| MHWN | — | — | — | 9 | 5 | 2 | 27 | 17 | 13 | 10 |
| 5 meters from HT | — | — | — | — | — | — | — | — | — | — |
| 10 meters from HT | — | — | — | — | — | — | — | — | — | — |

B: on the western bank at stations 11–20.

| | Stations | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Level | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| MTL | — | 6 | 58 | 30 | 225 | 200 | 178 | 180 | 167 | 95 |
| MHWN | — | 3 | 11 | 7 | 24 | 9 | 7 | 9 | 9 | 20 |
| 5 meters from HT | — | — | — | — | 3 | 3 | — | — | — | 8 |
| 10 meters from HT | — | — | — | — | — | — | — | — | — | — |

tide level. Their numbers were found to decrease towards the high water mark, till none could be found at 5 m from the high tide mark except at stations 15, 16 and 20.

The snails were absent at stations 1 to 3 and 11 which are located at the boat station. Generally, however, the snails were more abundant on the western bank (stns. 12 to 20) than on the eastern bank (stns. 4 to 10) (Table 1). Grasses (*Cynodon* sp., *Andropogon* sp.), and sedges (*Cyperus* spp.) were more common at stations 1 to 3, 11, 12 and 20, whereas halophytes (*Arthrocnemum* sp., *Salicornia* sp. and *Suaeda* spp.) were abundant at stations 8 to 10. The remaining stations are characterized by the presence of mangrove vegetation.

*C. cingulata* were rarely found on the mangrove vegetation which at this locality was found to extend from high tide level to the landward zone.

The snails were most abundant in the shallow regions on the mud flats extending from low tide to high tide level, where their numbers reached to about 600/m$^2$ (Fig. 3B). The snails were found to avoid steep slopes. They were absent in the bottom muds in the middle of the canal and in regions which are seldom exposed and also in the sandy zones near the mouth of the canal.

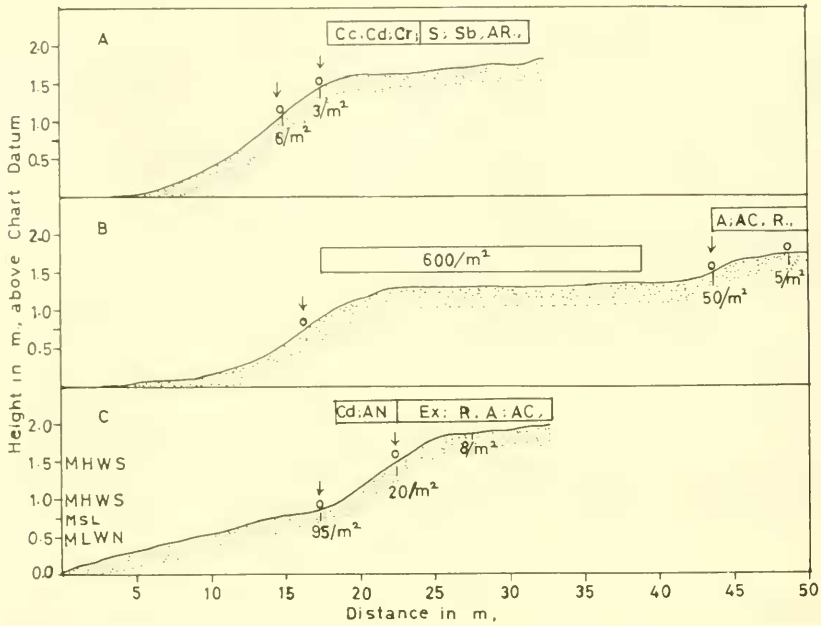


FIG. 3. Profile of 50 m transects showing the distribution of *Cerithidea cingulata*, grasses, sedges and mangroves at A: Station 12; B: between stations 15 and 16; C: Station 20. A = Avicennia Spp.; AC = Acanthus ilicifolius; AN = Andropogon Sp.; AR = Arthrocnemum fruticosum; C.c = Cyperus compressus; C.d = Cynodon dactylon; C.r = Cyperus rotundus; EX = Excoecaria agallocha; R = Rhizophora Sp.; S = Suaeda Spp.; S.b = Salicornia brachiata.

## Habits

The snails were observed on several occasions between January to December 1979, on the mud flats at Nizampatnam canal, which are exposed only at low tide.

During the February–May period, large numbers of *C. cingulata* of 2–3 cm shell height were found as beds or mats in the shallow regions between the low and high water levels. Schools of variable size, often consisting of several hundred individuals moving together, forming a continuous monolayer of snails, were observed on the damp surface of the mud-sand bank. There were also many individuals wandering freely, not attached to schools. Schools were observed to move in all compass directions, usually downhill. As the schools reached the water level and became submerged, they were found to move uphill although exceptions were observed. During high tide the underwater schools were found to move uphill toward the water line and were less closely packed than those on the bank.

During the June–January period, *C. cingulata* were sparsely distributed and were confined to pools on the bank or to the runnels draining from the marsh. The snails seemed generally smaller than the population seen before (February-May period) and included a size group of 0.3 to 1.5 cm shell height.

In the laboratory, when *C. cingulata* is placed in a dish of water and left undisturbed for a few minutes, it goes to the edge of the dish and moves in a clockwise or anticlockwise direction. No specific tendency to turn to the right or left, was observed.

In stock tanks, the snails newly put in tended to climb upwards on the vertical sides, but when provided with a natural substratum, usually a mud-sand substrate, they found to burrow. When buried, the snails were observed to establish contact with the surface with two burrows located near the anterior end of the shell.

On exposed mud flats, the snails were observed to move predominantly downhill. This reaction was imitated in the laboratory. When a group of specimens were placed at about two-thirds away up the slope, over a plane of glass sheet inclined at a small angle to horizontal, most snails (90%) moved

downhill. The same behaviour was elicited even when the snails were placed facing random directions.

## DISCUSSION

The present investigation attempts to compare the distribution and behaviour of a local tropical mud snail, *Cerithidea cingulata*, with the other *Cerithidea* spp. distributed in the Indo-Pacific region, and the temperate forms, *Hydrobia ulvae* and *Nassarius obsoletus* which are common in the estuaries of Europe and east coast of north America. *C. cingulata* is restricted to the warm waters of the Indo-Pacific region and is common in the estuaries and backwaters on the east and west coasts of India.

A comparison of the habitat zones of *C. cingulata* with the other *Cerithidea* spp., *N. obsoletus* and *H. ulvae* shows that all the forms prefer muddy shores and are intertidal in their distribution.

Macnae (1968) found that *Cerithidea* spp. are commonest in the landward fringe in the Malayan mangroves, while on a west Malayan mangrove coast, Berry (1975) observed a horizontal distribution of about 700 m for *C. obtusa* from the estuarine edge of the forest to the landward fringe. In comparison with *C. obtusa* the vertical range and horizontal distribution of *C. cingulata* are very much more restricted, as the vertical tidal range in the Nizampatnam canal is only about 1 m and the shore is slightly at an elevated level. *C. cingulata* are seldom present above EHWS and below MLWS indicating that the animals require some amount of exposure.

*Cerithidea* spp. were found to climb up the trees with the rising tide (Macnae, 1968; Berry, 1975). *C. cingulata* was also found to behave in a similar way at Machilipatnam, South India (Murty & Balaparameswara Rao, 1977). At Nizampatnam, however, *C. cingulata* was rarely found on trees and this is probably due to the distribution of mangrove vegetation above MHWS.

The snails were absent at stations 1 to 3 and 11 which are located at the boat station, and they were also more abundant on the western bank than on the eastern bank on the Nizampatnam canal. This may be due to frequent disturbance to the substratum at the boat station and constant agitation of water due to the movement of fishing boats which in this canal usually move along the eastern bank. This also suggests that the snails prefer calm regions.

The differences observed in the distribution and abundance of *C. cingulata* between February–May and June–January periods can be attributed to the salinity fluctuations prevailing during the above periods. The inshore waters of the east coast of India are subjected to wide fluctuations in salinity due to the prevailing currents skirting the coast, which move in a northerly direction during January–June, when the warm and more saline waters from the Indian Ocean enter the Bay, and in the opposite direction during the other half of the year, July–December, when the coast is lashed by the south west and north east monsoons, resulting in flooding of the rivers on the east coast (Ganapati & Murty, 1954; Ganapati & Ramasarma, 1958). At present the reasons for their sparse distribution during June–January period are not known; the snails might have migrated to other localities where the salinity conditions are favourable or died. Studies on the salinity tolerance of the snails have shown that *C. cingulata* is less tolerant to freshwater.

A comparison of the behaviour of *C. cingulata* with that of *N. obsoletus* and *H. ulvae* shows that all the three forms are negatively geotactic when immersed in water and positively geotactic when exposed (Crisp, 1969; Newell, 1962; Anderson, 1971).

Newell (1962) and Anderson (1971) observed that the British mud snail *H. ulvae* floats and migrates upstream at high tide and found that this provides an important means of feeding additional to that of the mudbrowsing phase. Similar floating behaviour has not been observed in *C. cingulata* which is mainly a deposit feeder. In the American mud snail *N. obsoletus* also no floating behaviour has been reported (Crisp, 1969).

Batcheldor (1915) and Sinderman (1960) have described an autumn migration of populations of *Nassarius* from littoral to sub-littoral where they overwinter in a quiescent state and return to mud flats in the spring. There is no evidence of such migrations of *C. cingulata* and this may be due to the absence of well marked seasonal variations in temperature in the ambient conditions of a tropical location such as Nizampatnam.

Newell (1965) found that *Hydrobia ulvae* prefers fine deposits, but Wells (1978) reports that *H. totteni* favours intermediate grain sizes. Crisp (1969) observed that *Nassarius obsoletus* prefers substrates with abundant food. *Cerithidea cingulata* has been shown to prefer mud-sand substrates and the details have already been reported by Balaparameswara Rao & Sukumar (1980).

## ACKNOWLEDGEMENTS

The authors wish to thank Prof. Y. Radhakrishna, Head of the Department of Zoology, Nagarjuna University, for facilities and encouragement.

## REFERENCES CITED

ANDERSON, A., 1971, Intertidal activity, breeding and the floating habit of *Hydrobia ulvae* in the Ythan estuary. *Journal of the Marine biological Association of the United Kingdom*, 51: 423–434.

BALAPARAMESWARA RAO, M. & SUKUMAR, R. V., 1980, The response of a tropical estuarine gastropod *Cerithidea cingulata* (Gmelin) to different types of substrata. *Hydrobiologia*, 78: 191–193.

BATCHELDOR, C. H., 1915, Migrations of *Ilyanassa obsoleta*, *Littorina littorea* and *Littorina rudis*. *Nautilus*, 29: 43–46.

BERRY, A. J., 1975, Molluscs colonizing mangrove trees with observations on *Enigmonia rosea* (Anomiidae). *Proceedings of the Malacological Society of London*, 41: 589–600.

CRISP, M., 1969, Studies on the behavior of *Nassarius obsoletus* (Say) (Mollusca: Gastropoda). *Biological Bulletin*, 136: 355–373.

FENCHEL, T., 1972, Factors determining the distribution patterns of mud snails (Hydrobidae). *Oecologia*, 20: 1–17.

FENCHEL, T., KOFOED, L. H. & LAPPAHAINEN, A., 1975, Particle size selection of two deposit feeders, the amphipod *Corophium volutator* and the prosobranch *Hydrobia ulvae*. *Marine Biology*, 30: 119–128.

GANAPATI, P. N. & MURTY, V. S. R., 1954, Salinity and temperature variations of the surface waters off Visakhapatnam. *Memoirs in Oceanography, Andhra University Series* No. 49, 1: 125–142.

GANAPATI, P. N. & RAMASARMA, D. V., 1958, Hydrography in relation to the production of plankton off Waltair coast. *Indian Journal of Fisheries*, 2: 84–95.

LIM, C. F., 1963, A preliminary illustrated account of mangrove molluscs from Singapore and south-west Malaya. *Malayan Nature Journal*, 17: 235–239.

LITTLE, C. & NIX, W., 1976, The burrowing and floating behavior of the gastropod *Hydrobia ulvae*. *East coastal Marine Science*, 4: 537–544.

MACNAE, W. C., 1968, A general account of the fauna and flora of mangrove swamps and forests in the Indo-West Pacific region. In *Advances in Marine Biology*, 6: 73–270. eds F. S. Russell & C. M. Yonge, Academic Press, London & N.Y.

MURTY, A. S. & BALAPARAMESWARA RAO, M., 1977, Studies on the ecology of mollusca in a south Indian mangrove swamp. *Journal of Molluscan Studies*, 43: 223–229.

NEWELL, R. C., 1962, Behavioral aspects of the ecology of *Peringia* (= *Hydrobia*) *ulvae* (Pennant). *Proceedings of the zoological Society of London*, 138: 49–75.

NEWELL, R. C., 1964, Some factors controlling the upstream distribution of *Hydrobia ulvae* (Pennant) (Gastropoda: Prosobranchia). *Proceedings of the zoological Society of London*, 142: 85–106.

NEWELL, R. C., 1965, The role of detritus in the nutrition of two marine deposit feeders, the prosobranch *Hydrobia ulvae* and the bivalve *Macoma balthica*. *Proceedings of the zoological Society of London*, 144: 25–45.

PECHENIK, J. A., 1978, Adaptations to intertidal development studies on the mud snail *Nassarius obsoletus*. *Biological Bulletin*, 154: 282–291.

RADHAKRISHNA, Y. & JANAKIRAM, K., 1975, The mangrove molluscs of Godavari and Krishna estuaries. In R. Natarajan ed., *Recent Researches in Estuarine Biology*, 1: 177–184. Hindustan Publishing Corporation, Delhi.

SINDERMAN, C. J., 1960, Ecological studies of marine dermatitis-producing schistosome larvae in northern New England. *Ecology*, 41: 678–684.

WELLS, F. E., 1978, The relationship between environmental variables and the density of the mud snail *Hydrobia totteni* in a Nova Scotia salt marsh. *Journal of Molluscan Studies*, 44: 120–129.